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ABSTRACT

Biometric communication research is defined as research dealing with the information impact of a film or television show, photographic picture, painting, exhibition, display, or any literary or functional texts or verbal stimuli on human beings, both as individuals and in groups (mass audiences). Biometric communication research consists of a series of specific tests--sondages performed by psychophysiological instrumentation on live persons who receive the media information input. Information processing perception and storages within the human world are seen as an energetic process with catalytic characteristics; therefore, what is measured in biometric research are energetic changes in the human body due to the information impact from films, television, radio programs, or generally due to the perception of the informational environment. (Author/LLS)

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Dr. M. F. Malik:

Biometric Communication Research

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Introduction

Biometric communication research deals with the information impact of a film or television show, photographic picture, painting, exhibition, display, or any literary or functional texts or verbal stimuli on human beings, both individuals as well as on groups (mass audiences).

Biometric communication research consists of a series of specific tests — sondages performed by the psychophysiological instrumentation on live persons who receive the media information input.

I see the information processing perception and storages within the human world as an energetic process with catalythic characteristics.

Therefore, what we measure in biometric research are energetic changes in the human body due to the information impact from films, television, radio programmes, or generally due to the perception of our informational environment.

A number of terms should be clarified first, before we go into the specifics of testing methodologies, instrumentations or various approaches taken in past decades by various researchers.

The disciplines or fields, which substantially helps or clarify the the subjects, are information and system theories, cybernetics, neurology, neurophysiology and neuropsychology.

I Biocybernetic Basics of Biometric Research

Under term "information" I understand in a broader sense energetic change with catalythic character. In this sense, information is a basic component of every television program, film, theatre, play and radio news. The previous definition is connecting information in media with information processes, going on in and between plants, minerals and animals.

Under term "design" I mean the organization of this process toward determined goal and impact.

In our world, between human beings, information processes have a specific structure, which I call an information chain. In simple scheme, it has three parts:

Information Source	Transmission Conditions	Receiver and his response
(TV program, film, play news)	(readers room, cinema-theatre TV set, auditorium, exhibition space)	(people, viewers TV watchers)

If you change any part of the information chain, the information itself is changed. For a long time it was believed, that an information source contains all the information itself, and nothing could change it. Now we know, that an information source carries only parts of information, capable to start catalythic process. Sometimes an accidental structure (stone, cloud, view in a street or country) could be an information source. Information sources, capable to start the information chain in most cases of human perception, are called logistic or artistic structures.

Transmission conditions (readers room, cinema theatre, TV set, auditorium, exhibition space or in a broader sense any perceptual environment) was believed to be only a passive pipe, through which a message is delivered on destination, to the people. This exists, when information is delivered immediately.

The situation could be reversed, if transmission is occuring for a longer period of time or on large distance or quantities TV programs, beamed through a television set for weeks or years). The repeated transmission conditions are stimulating a perceptual stereotype, specific for each transmission medium (medium itself may carry important and influential, but never pronounced messages).

Receiver (viewers, audience of theatre, play or concert, readers) were believed to be a consumer of information source. This is far from the truth. An information source is never physically consumed, it is perceived. This perception could lead, but not necessarily so, to the comparative information processing and retention in the human brain. A quantity of information, its structure or succession is not the same, as in an information source, and can be, and in most cases is, diametrally different. By retention, only part of information quantity released from information source, is factually stored, in the human memory.

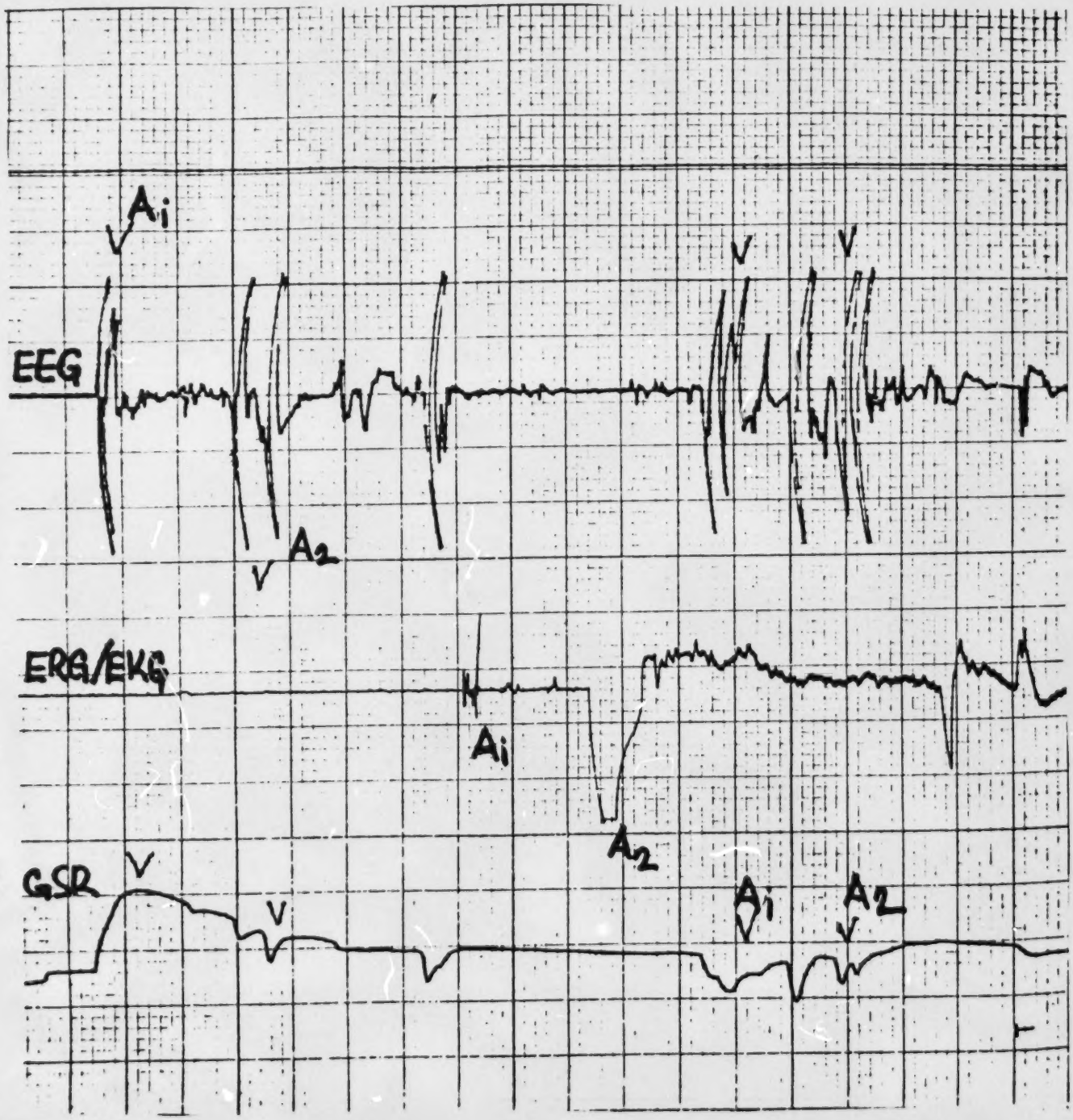
By the processing and storing of information in (viewer's) brain, other processes are happening, which incoming information is starting as a catalyser. In this sense we are witnessing the information impact. This may provoke the receiver's response. This response could be a latent one (on meta-level) or a pronounced, behaved one. It could also start another information chain.

Information chain is existing in a certain time and space.

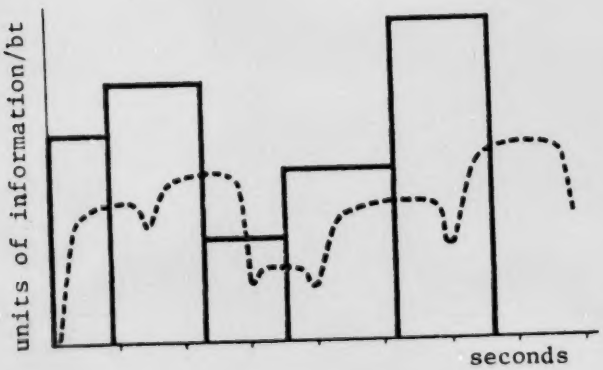
The time of information production and information perception has different axis.

Production time is very well known in media, (time necessary to produce, organize or structure certain segments or complicated information), as well as transmission time (the airing time in television, screening time for film). The least known is a perceptual time. It is commonly believed, that the time

of transmission or performance should be identical with the time of information perception. Even if it seems to be in common understanding in human communication modes, it is not. Here is an example of multichannel biotelemetric recording, showing the perceptual time differences from the information input, till the meta-level response:



As you can see, the time differences are in the mili seconds range. In older times, these time segments had little or no meaning. But, with the development of large successive complexes of information (film, play, television program), those perceptual delays are causing the overlaps of information. When one information quantum is processed, the other could not be processed in the same range or intensities. Even if the short term memory could delay certain quanta, the constantly incoming information is more and more overlapped:



overlaps in the information cascade

The overlaps in information processing are typical for information complex, called information cascade. There are two different kinds of information cascades: one, when perceiver (people) had their own freedom to perceive one piece, part of information after another at their own pace (exhibition, gallery, book). This I call horizontal, linear cascade. Usually, there is great freedom of perceiver not only toward individual perceptual time, but also toward the freely chosen succession of pieces. The second information cascade is typical by fixed, programmed succession and time for perceiving of pieces of information (film, television program, theatre, play, concert) which I call vertical, structural cascade.

The high overlaps are typical for vertical information cascade. Each piece of information (scene, shot, sequence) is perceived in time, called perceptual time, varying with different groups of people, a different city, country, age or century.

There is an important geneologic and histologic phenomenon in perceptual time speeds. During the space of human life, a person perceives everything with different speed and different manner. Also, during the centuries the perceptual time had changed. People in 1470, 1880, 1920 and in 1973 were perceiving their information worlds with different speeds. I would say, that in contemporary time, the speed of perception, especially on American continent, is the fastest one ever known. This, of course, does not mean that all the perceived informations are fully processed and stored. But, in a certain sense, nowadays we are living more, than one perceptual life generation span. Compared to the fourteenth or seventeenth century, the contemporary man is living five or seven perceptual live spans during his/her own life. This may be one factor in the complex called generation gap, or the complaints that a son cannot understand his father's conception of life and ideas (if the father is perceptually his great-grandfather).

If we know the perceiver's way of information processing and storing, the complex of all his habits and approaches toward information we could call perceptual spectrum of (mass media audience).

The perceptual spectrum of audience is varying with time and space. The human environment, culture and history (tradition) is influencing highly the way people are perceiving the world. The similar environment, culture, tradition could group the individual perceptual stereotypes into a common way of perceiving. This process is basic for the development of mankind. In tribal societies, man had fixed first information stereotypes (ecologic stereotypes of ways for hunting. tool production), developed highly fixed stereotypes (language, alphabets) and, coming toward highest development in his environment, culture and traditions, diversifies those lengthy and costly developed codes.

In this sense, we are now dealing in mass media with highly diversified audience. No longer is it true the "average viewer", or "average profile" of television or film audience. Very small groups of audiences are differing in habits of perception, and only in very high abstract (not necessarily the same) are joined together and understood as common signs. We are now dealing with "multilayered perceiver", each has layer of mind with different specification of interests, preferences in time (no longer the prevailing "prime-time", and specificities of place, country, town). The diversification of transmission centres (cable television) is speeding up this process. The same has happened in exhibitions, museums, galleries. In those fields designers had developed a specific way, how to attract this "multi-layered visitor" (multi-media exhibitions, multi-programmed galleries and museums) to the information source.

When the receiver of information has the multi-layered characteristics, it becomes difficult or impossible to transfer one information source from one place or group of receiver, to another. The same information source is understood quite differently in different places or for different groups of people.

The logistic understanding (what story or theme or artwork is about) becomes less meaningless for people with different perceptual stereotypes and spectrum. The most misleading things are happening, when some people tear out the information source (film, TV program, painting) or its part and put it in a separate, isolated place, then start to judge the values of it. Finally, this is coming toward the plain formative judgements, of no value for majority of receivers (mistake of most film and television and juries festivals). Each medium has also its geneology of perception. In the beginning, with the first appearance of new medium, the external formal parts are carriers of major influence; when becoming used to the medium, the semantic part of information is becoming understood, and when those semantic parts are becoming too easily understood, after long exposure to the medium (film, television) the formal parts once more are closing this eclipse with high importance for receiver.

The same cycle is happening, when time base is introduced in any medium by execution ot theme: When the theme is presented too slow, the small, sometimes unimportant formal details become carriers of messages; when presented in comfortable speed for perception, semantic characteristics are becoming most important; when presented too fast (faster, than average perceptual speed), the content of message could become unimportant, leaving only external formal parts as carriers of message.

Knowing the role of time and space in information chain, it becomes visible, that creator of information source could not alone outline all the characteristics of the source, not knowing the perceptual spectrum of the audience. This does not mean, that artist must be on tail of audience, fullfilling all their wishes. But respect for information chain assures the artist the success of his projected art work. (This plays similar role for business or political information chains structures).

Inside information cascade, the structure of time is becoming important. When placing important message into one time unit, it should be assured, that in that time most of audience is perceiving actively and are putting this information unit on high place of importance.

There are several basic facts, influencing the structure of time in any information chain:

1. The basic (metabolic) perceptual rhythm: Human perceptual system has the periods of high operational sensitivity, and periods, where, due to the metabolic changes, the functions of sensors or channels are slightly subdued. This is happening (with great deviations due to age, physical activities or imposed neural activities) approximately twice per minute. Children could have even three or more periods, older people could have one or less than Period per minute.

2. The imposed perceptual rhythm:

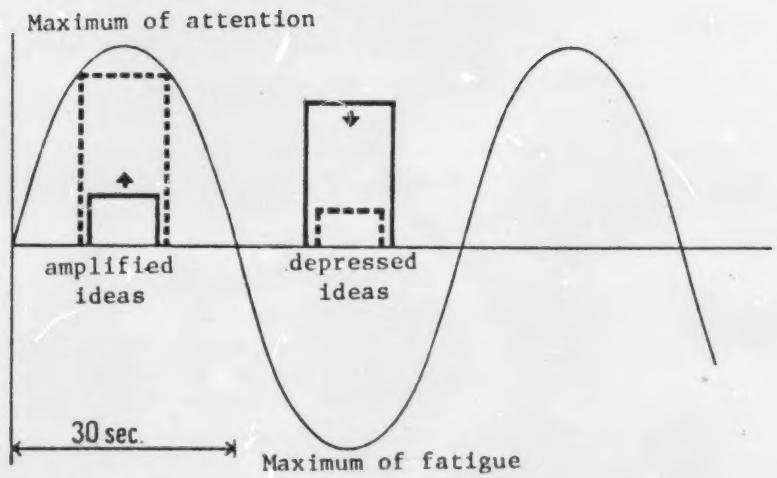
The previously mentioned basic rhythm could be modulated due to the input of information from information source or environment. The artis could fasten or slowdown the natural rhythm to a great extent. To do this, a certain time is always elapsing (of several minutes). To accomodate a person on a certain unusual perceptual rhythm, it takes for a single sensoric channel sometimes 10-15 minutes (overtures in operas), for multiple channel delivery 2-5 minutes. To change imposed rhythm it takes a much shorter time, but always this change goes over the one or more periods of natural perceptual rhythm.

3. The stress (oscillated) perceptual rhythm:

When using catalysts, creating stress waves in the human brain of perceivers (or "emotional" impact), it could happen, that the perceptual rhythm is irregular, with returning irregularities during short periods. This situation could create a "bouncing" effect, even if external stimuli is not present (we could add in mind certain dialogue, actor, situation even if they are not present on screen).

The perceptual rhythm is factually changing the information source parts (without anything changed in film, painting, photography, television program. This process is causing much of so called "subliminal effects" in tightly programmed media pieces (TV advertisements).

Example of "idea amplification" and "idea depression" due to the perceptual rhythm:



In this graph, if we place any information (dialogue action) in the positive part of rhythm (upper curve) peak of attention, the information impact of this sequence (shot, scene) will be increased at audience side, and if we place the same information in the negative part of the curve (rest period, or peak of fatigue), the information impact will be decreased, no matter how important this information is within its own structure.

When the informational environment is supplying the person with many informations in a short time, people start to join them together. This joint information is dialectically becoming a new quality, having a different content, sometimes in no connection with those previous contents of the parts. Large joints of information are called information patterns (those may evoke qualitative differnet responses from same sources).

(Example: You are driving on a highway at a low speed through suburban of town - you can distinguish every house. At high speed you perceive the same as housing entity. You are now unable to perceive detail features. One of those houses has a tower, you consider ugly. When driven through at a high speed, you may retain the memory of only this ugly tower, skimming over many nice features of houses without retention. Similarly, this could happen in television program, where certain shots have a very positive value, but the audience skims over and retains only negative details, because of position in successive speed. So is developed pattern of country, of car, of women and many others. This pattern stays for a certain time in the human memory, the specific parts of patterns decay, leaving only the indispensible features of it. This simplified pattern is called perceptual stereotype. For evoking such a stereotype, a minimal amount of distinguishing signs is necessary. (Example: in oval stone we could distinguish a human face, in a tree during fog human posture, in black dot on highway an automobile).

Information pattern and perceptual stereotypes are shaping taste and fashions of media audience. Both are an inclination of large segments of audience to distinguish the shapes or situations easy and fast with their memory or sensors.

Information pattern and perceptual stereotype in a certain way is close to the natural process, in which human eye is simplifying any picture falling onto retina, and after certain simplification inputed on neocortex of brain.

When many information patterns exists in daily life, less individual content of its parts is perceived or stored in memory. When several perceptual generations are living in the same time, as in our time, this process could be viewed as shallowing of previous ideas, contents or themes. Also it influences any theme presented by media, which is permitting easy information pattern transfer (television), and build a certain resistance, when presented in media with low information pattern transfer (abstract-painting). On the other hand, information pattern is allowing a faster transfer of ideas and meanings.

When information pattern is used for longer time and successfully in communication between people, it is becoming a symbol. There is nothing mysterious about any symbol in present or past use. High practicality, easy use, easy fixation in human memory are basic ingredients of any symbol. There is a particular way of fixations in visual symbols, which is basic in following a physiological characteristic of eye and its extension through visual nerve into brain. The audio symbols were highly fixed in speech and in certain tunes, musics.

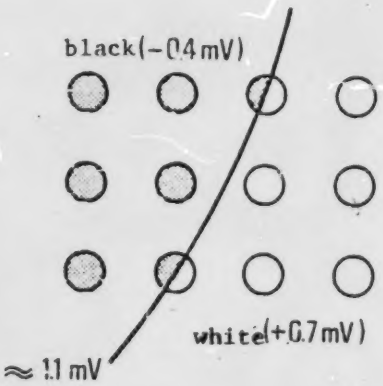
The base for understanding the information transfer between people is the mechanism of sensoric information perception, and information processing

in human body. Here, psychophysiology gives most of the leads in contemporary information design.

1. Visual Information Perception and Transfer:

Modulated light from the objects of outer world is falling on the retina of the human eye, causing electrochemical (and in case of spectral transfer chemoelectrical) signals, which are transferred through visual nerve, over neural network to the part of the brain, known as visual neocortex. On its way to brain the original signal is higly pre-processed. The neural pathway is working on several levels in high speed of microseconds, evaluating the incoming signals on several levels, before the selected parts of signal are reaching the brain. The first signal, reaching the brain is the parameter of intensity, with follow-up the distinguishment of contrast. The diminishing negative and positive intensities on picture are marking the way, human eye is examining any picture, to the indistinguishable grey. The eye is changing the absolute values into a subjective way (accomodation of eye is one the processes). The spectral readings (color perception) is coming in relative secondary and more limited range.

More different densities the picture contains, more time the eye needs to read it. The curve, we could draw as pathway of human eye is a reading picture I call visual reading curve. The path, in which the eye is moving from one density to another is not a straight one, but follows contours or lines in picture (as line or contour is interpreted as differential potential on retina cells, with cumulative readings stereotype, it facilitates sometimes 10-15 times faster reading, than of area with same densities).



On this line, projected on the human eye retina, (highly enlarged), black area is giving a signal -0.4mV, whiter area signal: +0.7 mV (in point report, the whiter area will be carried faster to the brain than the darker; if signals opposite, darker area carried faster) But on the border, the cumulative of two readings are carried, thus the border (contour) is reported the fastest way. If the same situation prevails in neighbouring cells, the cumulative effect is appearing in an extra polative way - it means even if the line is not complete, we understand the form as an entity.

Reading of any picture by the human eye takes time, even if those time segments are escaping our identification. With tachistoscope we can separate the visual reading curve into segments, from density to another density. With more sophisticated instruments, Eye Trac and Plotters, we can exactly outline the place and time eye is fixed in given movement. When we do an addition of all those fractions between densities, we obtain a general recognition time/ GRT/, which means the minimum time necessary to read an image. These times are usually under 1 second, maximum 2 seconds range. After the first reading, the eye comes back to the slowest reading sequence and finishes the second reading. After that to another slowest reading, so long as there are significantly different slow reading segments in the picture, or there is another limitation in the time of reading. There is no ohter explanation to this mechanism as the desire to explore more what is not understood or puzzling in the picture. Within one picture, we may achieve between 5-50 visual reading curves, sometimes much more. If person is left to its own pace, it may achieve more than 200 curves, before his/her interest about the picture ceases completely. Interpretation of the begining and the later visual reading curves is different, as it could be seen on multi-channel recording: Longer fixations of eye on the begining of reading means "not understood" areas, later to be explored in detail. In later parts, longer fixations are accompanied with high information processing activity in brain, there, stimulation process is going on.

If eye is perceiving the same densities in image, the preference process is following approximately these rules:

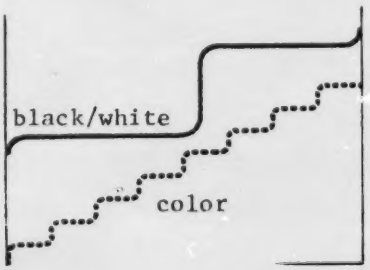
1. The centre of the picture (or the area of 3/4" gold cut" rule, fovea)
2. Areas close to the orthogonal axis (cells with firing when intercepting verticals and horizontals)
3. Areas close to the diagonal axis

4. Identification of fields (read clockwise in western hemisphere, counterclockwise in asiatic regions).

There are other preferences, which are either inherited or specific for some places only. The environment can influence such preferences - (Esquimos, New Yorkers). Preferences in the same densities are influenced by spectral characteristics. The eye reacts normally for spectrum segment between 440 and 770 Angstroms. The upper curve indicates the sensitivity of elements in our eye. This curve is not a characteristic for all the chain of color information. Information transfer of colors in human eye has two basic mechanism of resistance. For peak of human eye sensitivity, the spectral interception is working predominately. For the borders of spectrum (reds), the resistance mechanism is working with high intensity, evoking sometimes stress wave responses from human brain.

The significant difference is occuring in time axis for picture reading if black-white and color pictures are perceived. In case of color picture, the eye is able to perceive more information per given time unit (second), but eye has shorter time of fixation (and for thinking" about the perceived information).

In the case of black-white picture, the eye is perceiving less information per given unit (second), with longer fixations, but it has more time for information processing ("thinking" about perceived information).



A specific mechanism in human eye is in operation when movement is perceived (we know two modes of movement: internal-inside of picture, external-movement of picture, camera pan or tilt).

It always depends on angular differences, combined with basic picture parameters (contrast, brightness, hue, linear details), if the movement is perceived at all, or if it is fast or slow. Also, the previous picture environment, and following one (previous and following shot) is determining the effect of movement.

Volume of moving parts of picture is influencing the perceptually reported speed of movement. Moving big parts slowly will produce impression of higher speed more so than moving smaller parts slowly. Different densities moved across the screen produce different impacts (McLarren film "Spheres" is brilliant "etude" in this sense).

Specific impacts are experienced when two or more elements are moved in juxtapositions. Striking impacts are achieved if two or more different media are used with moving picture (actor-screen, still-moving, rotating picture).

Succession of moving pictures are influencing the speeds and axis, example: vertical movement-tilt is experienced usually on higher level than horizontal movement. But: 2-3 shots with static horizontal composition before little horizontal movement are changing this to big one; and if those preceding shots contained vertical compositions, then the horizontal movement would appear diminished.

2. Audio Information Perception and Tansfer:

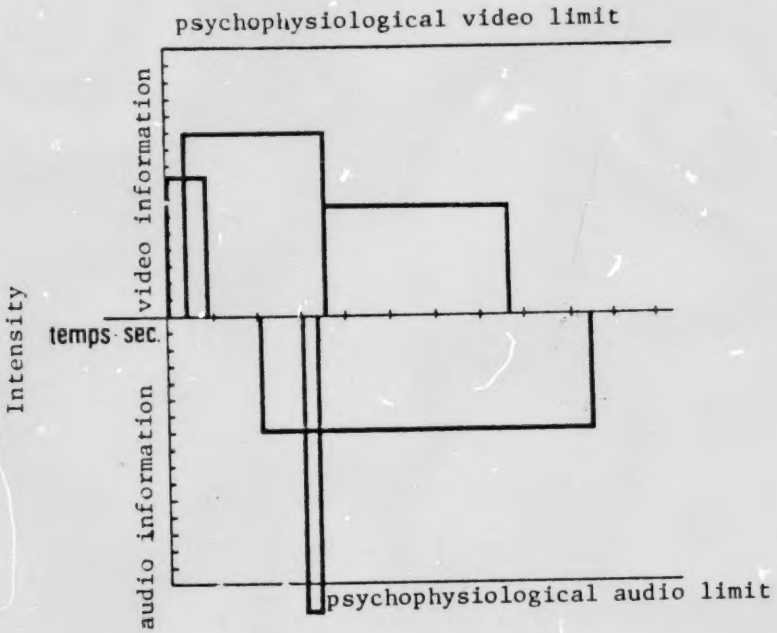
The human ear amplifies pressure waves from air in range of 14-16,000 Hz mechanically by bones and by fluid in inner ear, transferring those pressure waves into electrical signals, raching the audio neocortex of brain.

Certain ranges of audio spectrum are of specific impact to the human ear. For example, in the range of 500-3000 Hz the human ear is specifically sensitive to successive sounds (related to speech, articulations). In the range of 800-8000 Hz, a precise sensitivity to wavelength exists (music, tunes). The fluid mechanism inside the inner ear and connected organ also gives us the information regarding our position in space, and sometimes the roles of both work in connections (stereospace). The audio information from the inner ear reaches the part of the brain known as the audio neocortex by way of chemo-electrical impulses. There are two differences in the information impulse transfer in the visual neocortex: first, the audio neocortex is of markedly different size in each hearing person, and second, more parts of the neocortex are working when sound is perceived. The major difference in sound perception is in time base. While the visual element can be perceived and prepared for processing in 1/500 of second, sound processing rarely exceeds a time range of 1/50 of a second. For visual and audio information processing, the speed within the neocortex (between neurons) is relatively the same for both, but the extent of neural activity is different. In general, visual processing largely encompasses the surface of the brain neocortex, and the audio information processing is connected to a large extent to the hypothalamic parts of the brain. Then audio information can evolve easily and in many cases with emotions.

When visual and audio information is presented together, the differences should be respected. Before you say a word, an enclosed image could deliver a hundred bits of information for processing. When visual information is expolated within a certain time (talking face of TV screen), the sound information could evoke indirectional information transfer (emotional results from seeing the president's face on TV speech).

When visual information is either pre-processed or simplified (animation in TV ads), the sound information should be enclosed very carefully, and in a time-saving manner.

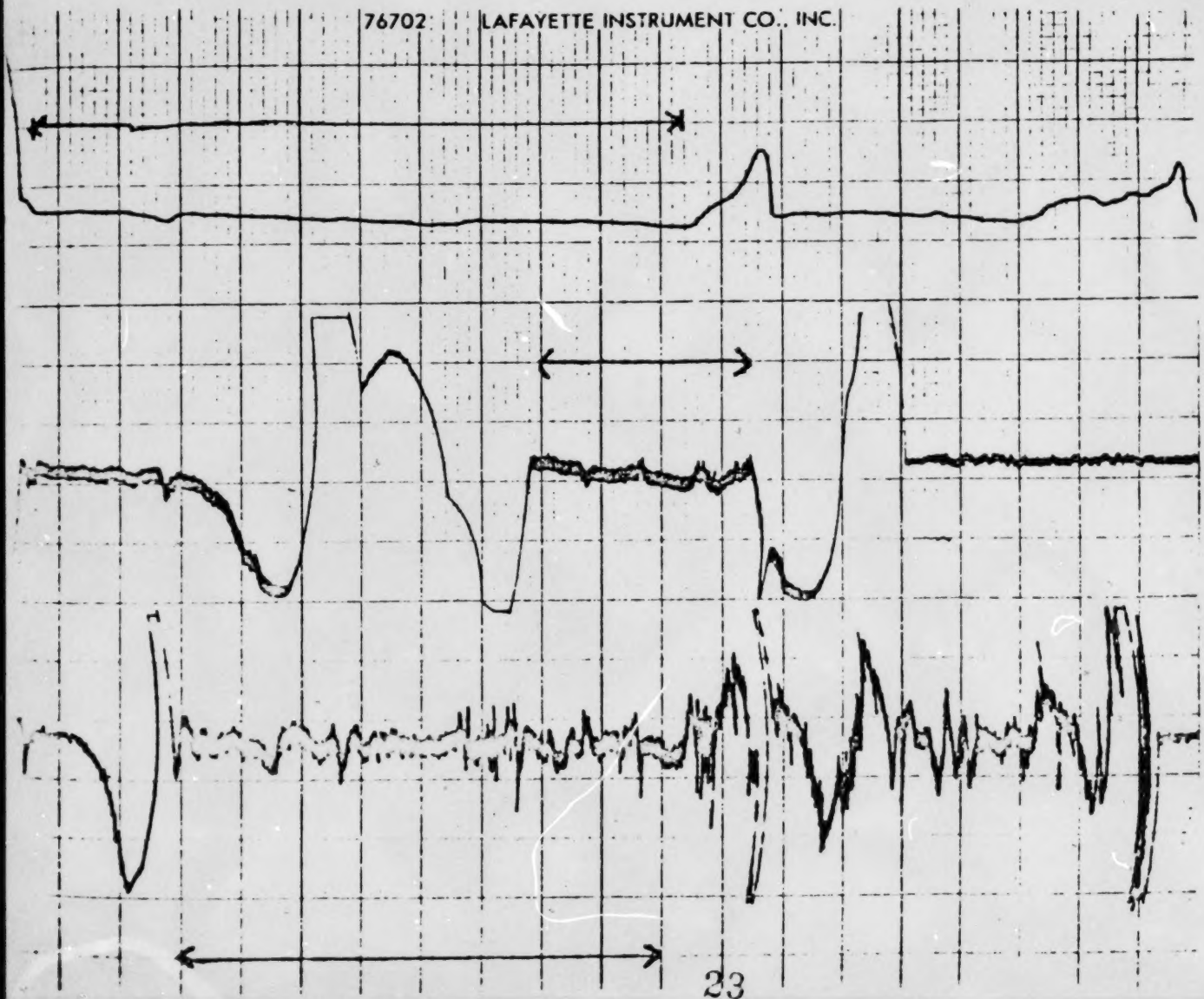
A simple Shannon-Ashby scheme could be employed for estimating audio-visual proportion in any information source.



It should be noted that, unlike the Shannon-Ashby scheme, in sound information measurement we add the intensity parameter into readability and information impact characteristics.

Generally, the combination of visual and audio information could be changed in the intervals close to the perceptual rhythm of perceivers. When a certain rhythm is established at the beginning of the film or TV program, there is a tendency to find the message of information source in the succeeding, even different, information channel.

In the places of changed information channel preference, these are the best points for feedback characteristics (co-operation of viewers).



There is a constant change in the perceptual spectrum when more information channels (audio and visual) are considered. (For example, regarding sound behaviour, American audiences in later (older) layer perceive 70:30/70% pictorial or preferentially pictorial and 30% sound information characteristics; and the younger layer has completely reverted the scheme to 40:60/40% of preference to visual, 60% preference or impact on audio). In connection with audio information perception and processing, a special note should be made about programmed audio complexes, or information codes, such as speech and music.

When we say a word, or play a tune, we cue the sound information to some particualr meaning, with fixed characteristics (according to the language or area of cultural tradition). In those cases, sound or word pronounced is a sympol of higher or lower structure. This structure is not contained in the information source (sound signal), but lies largely in memory perceivers, memory stereotypes or fixed feedback skills. This differs from person to person. The same word or musical sequence could have an entirely different meaning, even if the first step in information procession (identification and recognition) is the same for many people.

The visual code of music and speech (notation and writing) proved to be very efficient information codes. Greeks and Romans were dependent on oral codes but within their civilization was born also a dependence on fixed codes, in tune to that period.

Once again, when creating the audio-visual information source (film, TV program, theatre play) the time axis comes back significantly in nearly microscopic terms. If you say a word, it takes about 1/5 of a second. The reading of the same word takes about 1/20 of a second or less. The visual representation of the same code could be read in less than 1/150 of a second.

When we are coding certain information, we must consider time for decoding

with processing of transmitted information. Written code had for centuries counted with this, and the form of all manuscripts and books were designed after it. When the book is written in contemporary time, it battles the time constants of its environment, sometimes semantically understood only in a fraction of its content. (This may account for readers' return to poetry in past years).

3. Information Processing:

Sensoric information is processed in the human body by the brain which is composed of approximately 100 billion cells. These cells are of two kinds: neurons, which are the functions at certain times of brain activity. Each neuron has a cell body and connections called axons and dendrites (incoming and outgoing fibres). Between these bodies, and also between the connections, there are liquid gates called synapsis which combine electrical and chemical transfer of activities.

Numbers of neurons are more or less loosely interconnected. The specific electrical activity of the neurons in given time is called neuron circuit. A neuron circuit is the basic unit for information processing in the human brain. The activity of neuron circuits is commonly called "thinking". During this time, by repeating activities, more could happen than energy transfer: the chemical properties of synaptic gates, or even neuron cell properties are slightly changed. These changes which are more or less permanent, are the base of the human memory. Changes may happen on the synaptic level and a simple information unit is stored. Change may occur in the cell bodies withing a large area of cortex, we remember an information pattern, which is capable of starting or influencing many future information transfers ("ways of thinking"). If this chemical change is durable and is capable of influencing independently other parts of the brain, we are talking about stereotypes, skills. This process

of neural change on a electrochemical level, is close what we call learning. A single neuron circuit is not capable of processing or storing such an image as "tree" or "house". A multitude of neuron circuits are in operation not only at the very moment a person sees the tree, but also after, and the finally fixed memory is finished within hours from the moment of perception. If a person perceives several information units during a short time, certain activities of neuron circuits could be spotted before the information unit is perceived. When several or many neuron circuits are activated from the sensoric input, the inner feedback mechanism is not only further specifying the sensoric target (example, movement of eye), but is also building a very specific hierarchy in the brain; so, from the perception process, certain neuron circuits are left with higher energy potentials while other circuites are left with lower energy potentials. Energy transfer is the transmission medium in the brain. The sensitivity of neuron circuits are the primary gates through which transfer may or may not occur. The neuron circuits have a certain minimal energy level which can be increased or decreased metabolically or mentally. This "sensitivity" could also be changed due to the sensoric input causing later chemical change.

There are basically two mechanisms of neural transfer in the human brain:

1. Specific transfer: where intensity of incoming energy and characteristics (amplitude and time) determine the influence of certain neuron circuits. We could relate this transfer to "rational thinking".
2. Wave transfer: it could happen, that with certain sensoric or metabolic input, the neuron circuit triggers an avalanche of activities, sometimes in depth, involving various unrelated parts of the brain. We could relate this transfer to "emotions" or "emotional thinking".

A combination of both mechanisms very commonly happens in a person's life, and on the borders of such changes may occur "esthetic feelings" or "intellectual way of thinking".

If we are composing an information complex, such as a film or television program, these two mechanisms should compliment each other, rather than compete. In the stage of wave transfer, the intensive specific area transfer is subdued. On the other hand, if we prevail upon a transfer mode in part of the film or TV program, the change of transfer mode will be appreciated by the brain mechanism and transmitted with higher efficiency.

Certain specific audiences prefer one or another mode of information transfer ("emotive" or"pragmentic" audiences).

4. Information Storage:

When input from sensor (eye, ear) activates the neuron circuit, information is not only registered or retrieved, but something remains in the human brain: any electrical activity slightly changes many chemical substances the cell is made of or is reacting to. There are organic substances more susceptive toward electrical activity than others. In certain chemical configurations, the transfer or retrieval of information can be fastor slow, or none. The base of human memory is probably a chemical one. The time axis in human memory bears energetical characteristics.

The memory is not specific to only the brain. There are other cells in the human body which have "memory" characteristics. What is specific to the brain memory is that the chemo-electrical retrieval is compressed in unbelievable quantity and speed, even changing the factual stored information.

There are three levels of memory in the human brain and sensors. The first level is a sensoric memory, or input memory: the human being has refined his sensors toward the result (oncoming signal), and not toward the function.

Therefore, this first memory is an action, when the human eye views a certain part of the picture, or when one picture in film projection is passing another at a speed of 24 pps. The higher level memory is called short-term memory, and touches primary capacity of neuron circuits. This permits us to remember something like a telephone number just long enough to dial it. This could be expressed in time as a 20-40 second period. (Depending on the person using this memory, the time or quantity could be extended). The highest, most permanent storage occurs in long-term memory. This memory results within minutes or hours from moment of input and cannot be easily interrupted or erased. The build-up of such a memory depends largely on the chemical properties present in the brain and in the body at that time. The short-term memory is characterized by high electrical activity in the neuron circuit. The long-term memory shows up in electrical measurement latent electrical phase, but when similar, or when certain input is activating the neuron circuit, the response could burst out in high intensity, and the person "recall" the previous reminiscence.

The human memory is not a fixed energetic state of neuron circuit, but is a process which is build, is in existence and fails as our memories are built and fail. Chemical properties build up during the period of input fixation could range to a much larger extent than the initial input. It could also influence hypothalamic (emotive) processes and occasionally far-off non-related parts of the brain or body. Those influences on the further parts of the brain are closely related to the phenomenon of associated memory.

II. Methodology and Instrumentation in Biometric Research

There are three kinds of energy changes measurable in bioinformatics:

1. thermal changes (changes of body temperature)
2. electrical changes (EEC)
3. chemical changes (chemospectrographic)

Any of these changes can be interrelated at any time, with the time axis projected into each.

The interval between the changes at the same level is called biometric potential. So when you see the graphical records of certain variations, the peaks and lows in it are the record of these potentials. They correspond to the energetic processes in neuron systems, are activated via information input, processing or storage, and also many other processes not in connection to bioinformatics.

This process is very far from simple interpolations. Therefore if you see a big, large potential on the recording, it may not correspond in the interpretation to the same extent of the impact or vice-versa. Quite sophisticated diagnostics have been developed over the last forty years; from quantitative, comparative analysis to analog-digital 3-D Fourrier analysis of biometric data.

Also, information interception, processing and storage of information stimuli like film and television programs, are not seen as a static or only a quantitative impact - quite opposite, it is a dynamic, systematic process (matrix) which succeeds the actual time of the program presentations, and continues in addition to parts of the program reflected in the human mind, or other (subjective or individual) elements.

So far as we know, biometric research provides an unusually deep and

precise tool for insight into human bioinformatics.

Basic biometry laboratory could test a variety of stimuli, ranging from simple photographs, posters, films, TV programs, literary texts, scripts and stories, as well as actual documentary and news material.

For measuring the information impact of films and television programs on the human mind, the biometric laboratory consists of:

1. Sensoric scanning devices (electro-oculograph, combined with elector-retinograph, audimeter with audiospectrograph).
2. Cortical processing devices (elector-encephalograph with electro-chemospectrograph).
3. Control feedback devices (electromygraph, electrocardiograph, GSR and BSR monitoring channels, ENTG monitoring channel).
4. Registering devices (data-graphs, x-y plotter, polygraphs, digital converters).

This set-up is a basic one, and it could have many instrumentation variations.

For diagnostic purposes, the following devices are essential.

1. PDP 11/25 computer
2. 16k of core memory
3. AD-01 analog to digital converter
4. AA-11D digital to analog converter sybsystem with scope control unit
5. Textronix 613 storage tube display
6. TC-11 dual DEC tape drive (or RK-05 disk)

For programming service we employ:

DEC RT 11 operating system with system programs

DEC BASIC RT 11 interpreter

Graphic display routine for BASIC RT 11

Generally, there could be a theoretical division emphasis in the research of information source, transmission conditions and receiver feedback. There could also be technological differences or methodologies when searching for the visual, audio, or audio-visual input. Finally, there is a significant difference between the test subjects.

In praxis, all those aspects are present, when complex tests are conducted,

There are several basic laws, which must be followed in order to understand, and practically use the test results:

1. I presume, that every person receiving media input is different, specific, and could have a specific biometric response.
2. I persume, that transmission conditions could change the form and content of the same input.
3. I persume, that the results of tests by all the exactness must be of synthetic, cummulative character, containing also the parts of the information which has little or no relationship with measured input.

Therefore, the following methodological rules must be observed:

1. Before a test is made, a precisely programmed pre-test is a must. This is a key for further diagnosis of graphical test results. The stimuli for the pre-test must be as natural, as simple, and as similar for all tested subjects.
2. Any change, observable in the person's external behaviour must be recorded on the test, as any change, made by the instrumentalist in adjustment during the testing periods.
3. The recorded test should be verified by a battery of stimuli related questions, and coded on a test strip. If the verbal and direct sensory tracking conflicts, the test should be repeated.

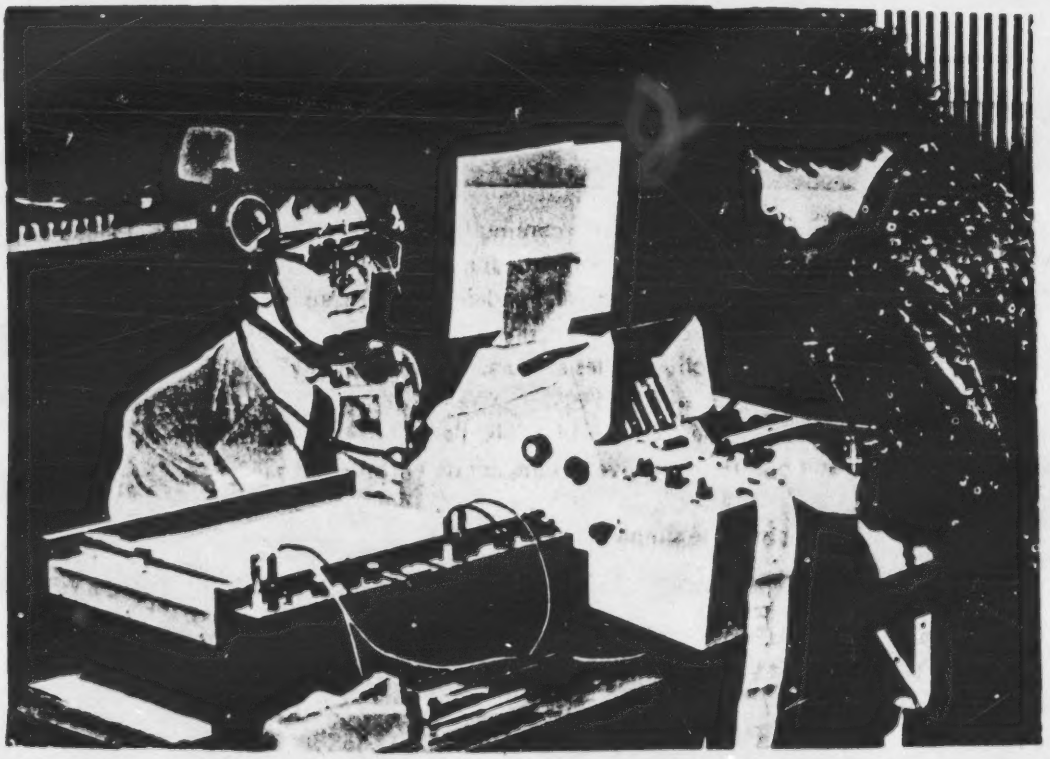
4. All tests should be read comparatively, cued by the time log of input.

Any test in biometric communication research could be made on single, or multiple channel biometric tracking equipment. Generally, if we use tests for pre-production searches, multiple channel tracking is the best mode. During the media piece production (film or television production, exhibition instalations), single channels could bring specific answers to the artists. For finished media products, once more multiple channel recording could answer most questions of information impact.

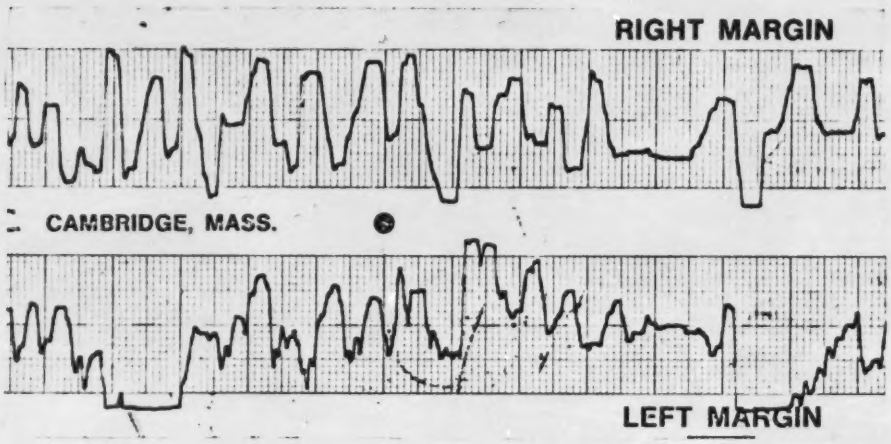
Single channel tracking

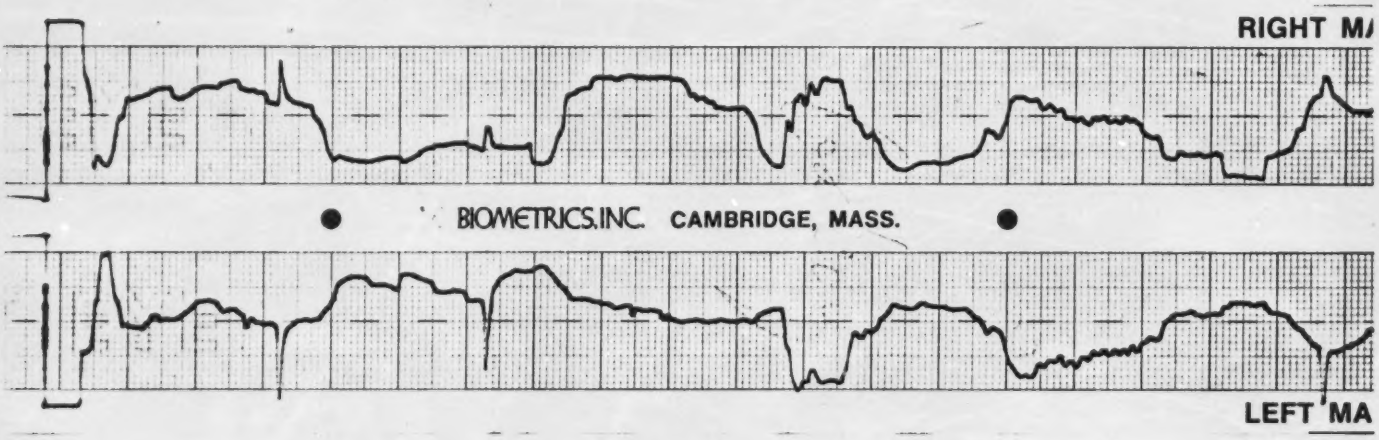
Generally, in this test case, we are extracting either part of the input, or part of the processed information. Therefore, the test could be the only generalised indicator of the whole information process.

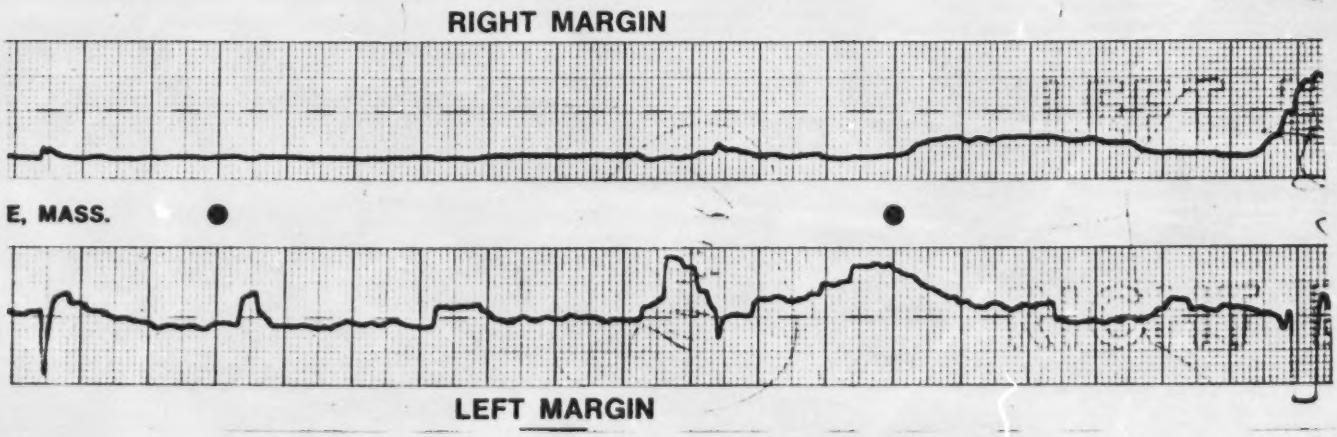
The best set-up of single channel tracking known is a combination of oculograph, electrooptical retinograph, recorder and plotter. This assures the tracking of the input, partial processing and immediate eye muscular response.



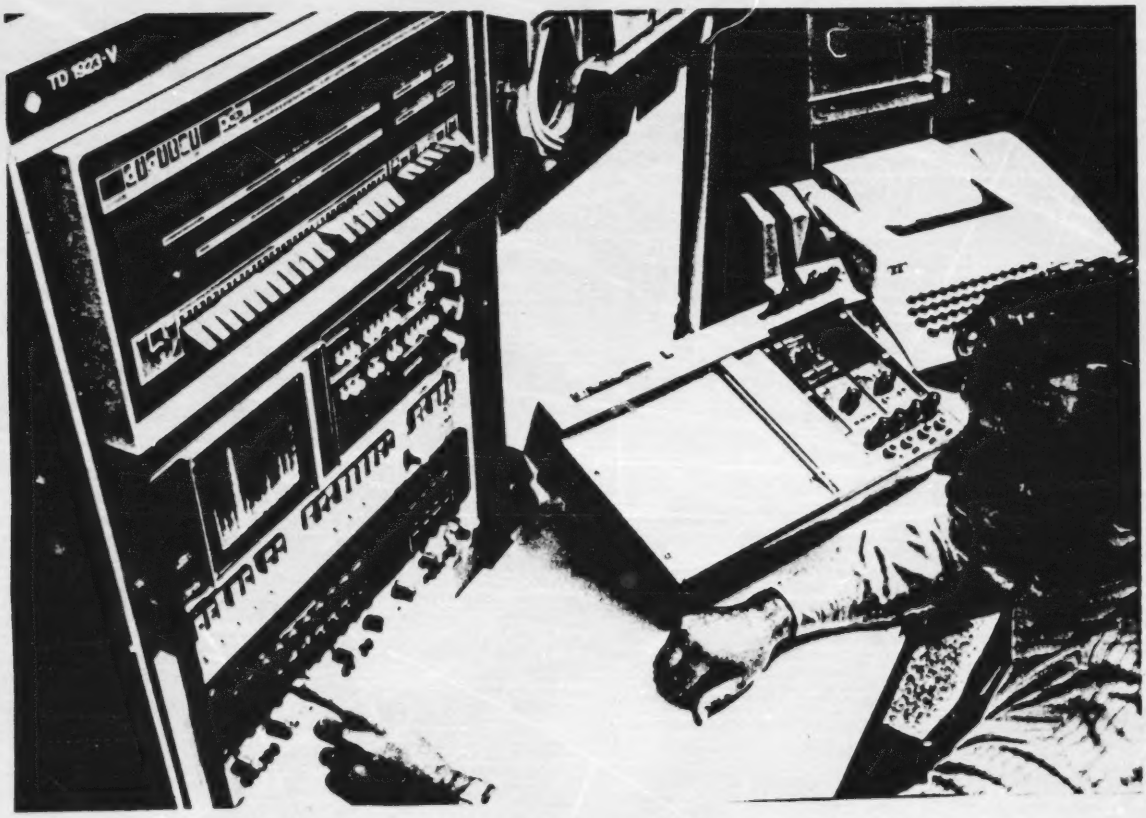
The result of such a measurement is a double graph, where the deviation of curves, matched, indicates the primary informational input in in visual channel.



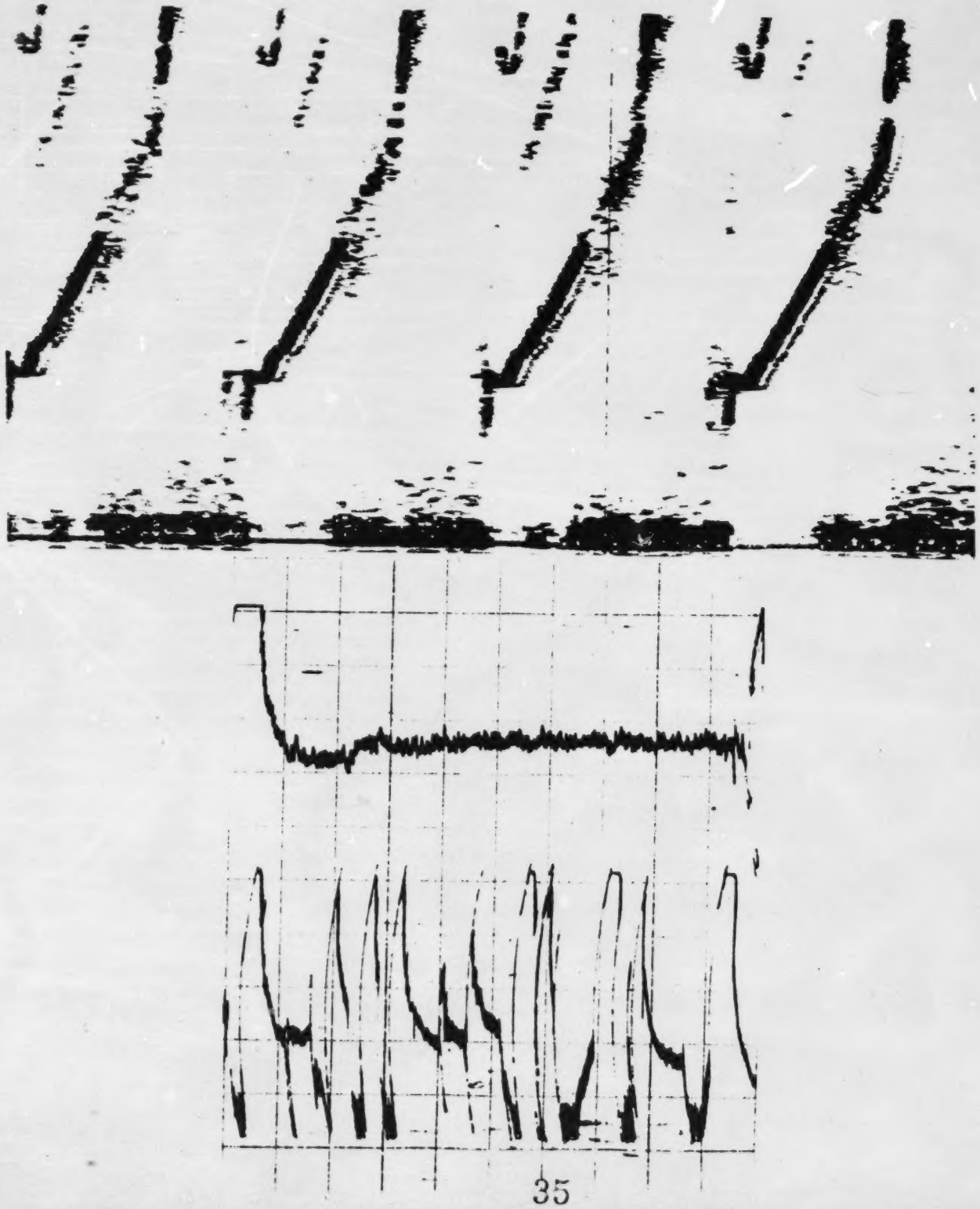




For single channel audio tracking, the best set-up is a combination of soundmeter, audiospectrograph, cerebral EEC and chart strip recorder. In this case, two analythic processes are recorded: the information source (of sound, music, voice, noise), and the processing of sound in the neocortex of brain.



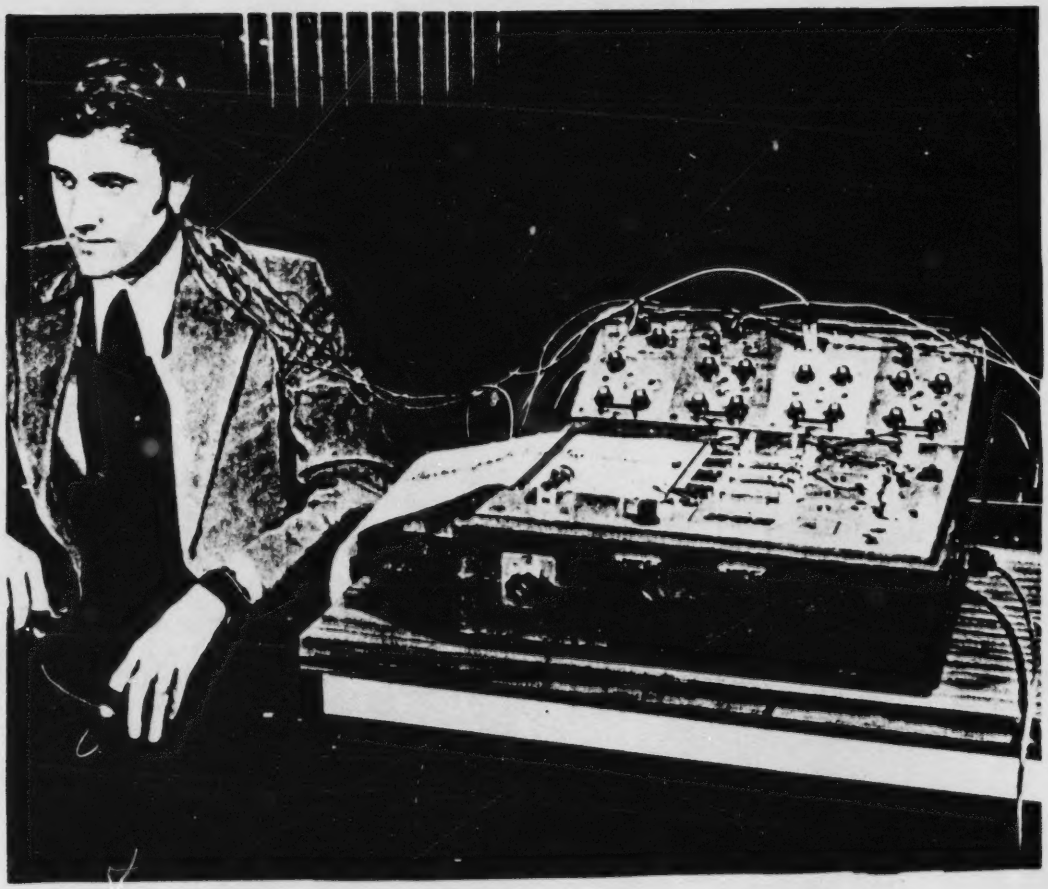
The result is a triple-graph, where the amplitudes, spectral lines and EEC from the audio neocortex are matched, indicating the audio input characteristics and audio processing phases.



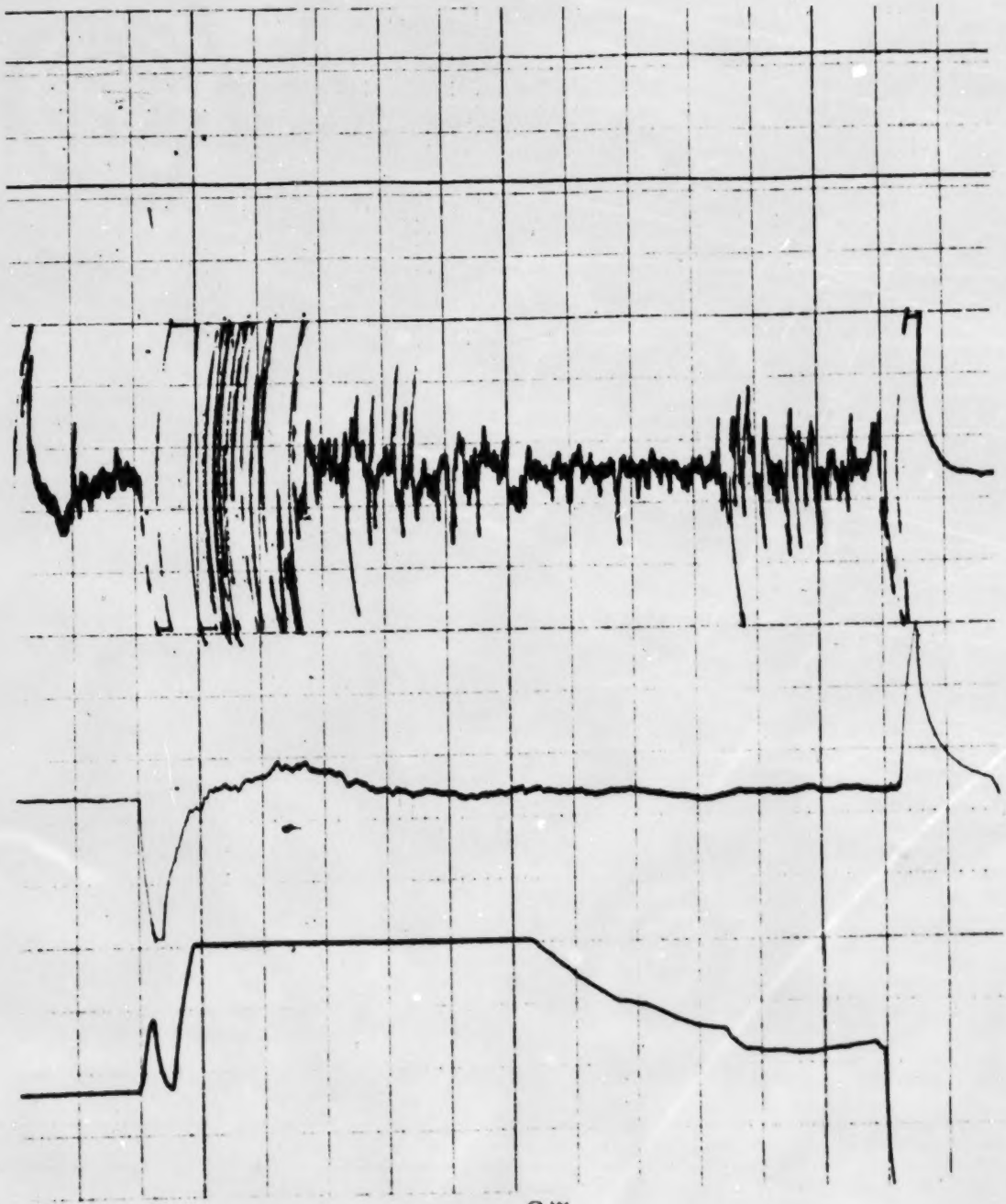
Multiple-channel biometric tracking:

When the complex input is occuring (film, television program), it is advisable to use more channels for tracking of information impact in test subjects.

The best set-up is combined from input track (visual or audio, or both), plus several processing channels (EEC, EKG, EMG and GSR), using one or more channels as verifying logs.



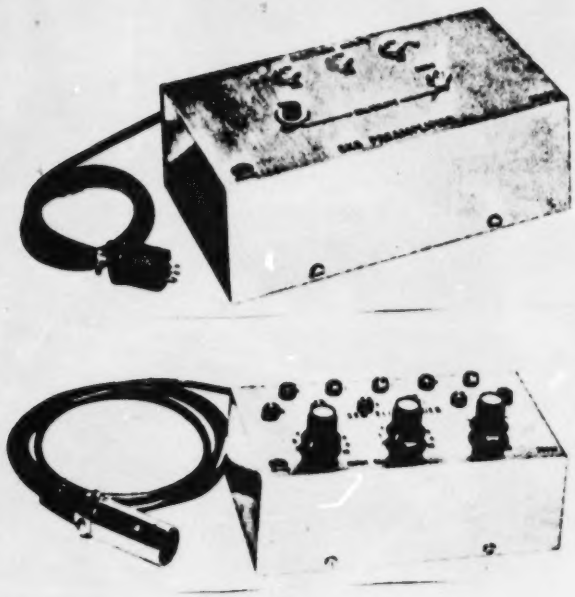
In this case, we are using the input channel as a time log. The EEC channel is the indicator of specific circuitry firings and the EDG is the indicator of stress waves developments. The EMG channel is a control for immediate responsive characteristics, and GSR is a cumulative responsive characteristics indicator. The time lapses between channels, read vertically, are control of follow-up for the same input.

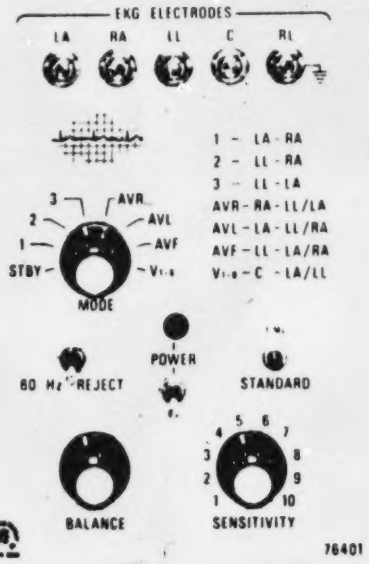


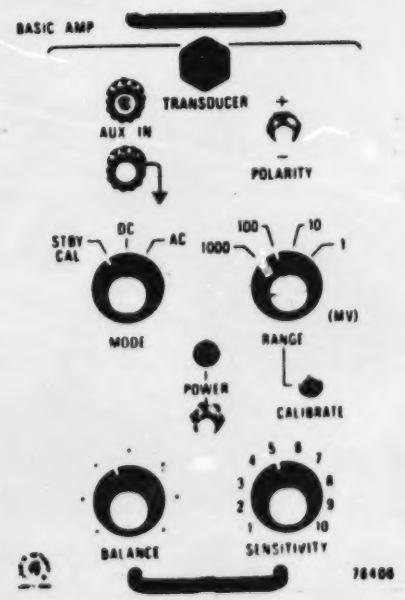
There are several difficulites in multi-channel recording:

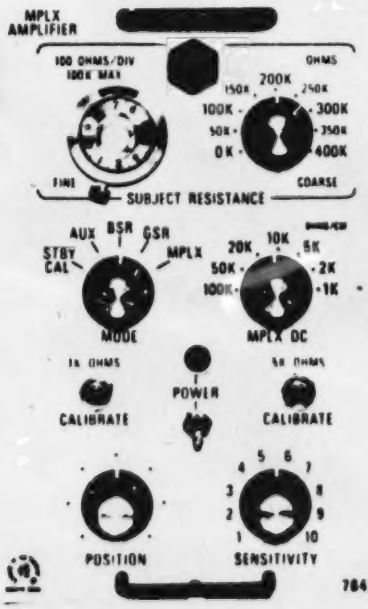
1. Information processing intensity of individual human neural systems vary highly. For this reason, pre-amplifiers and filters are used:

Picture of pre-amplifiers and filters



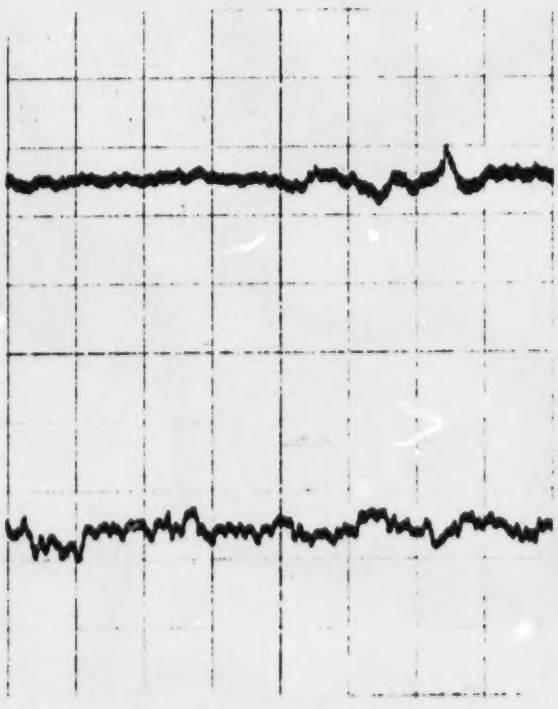






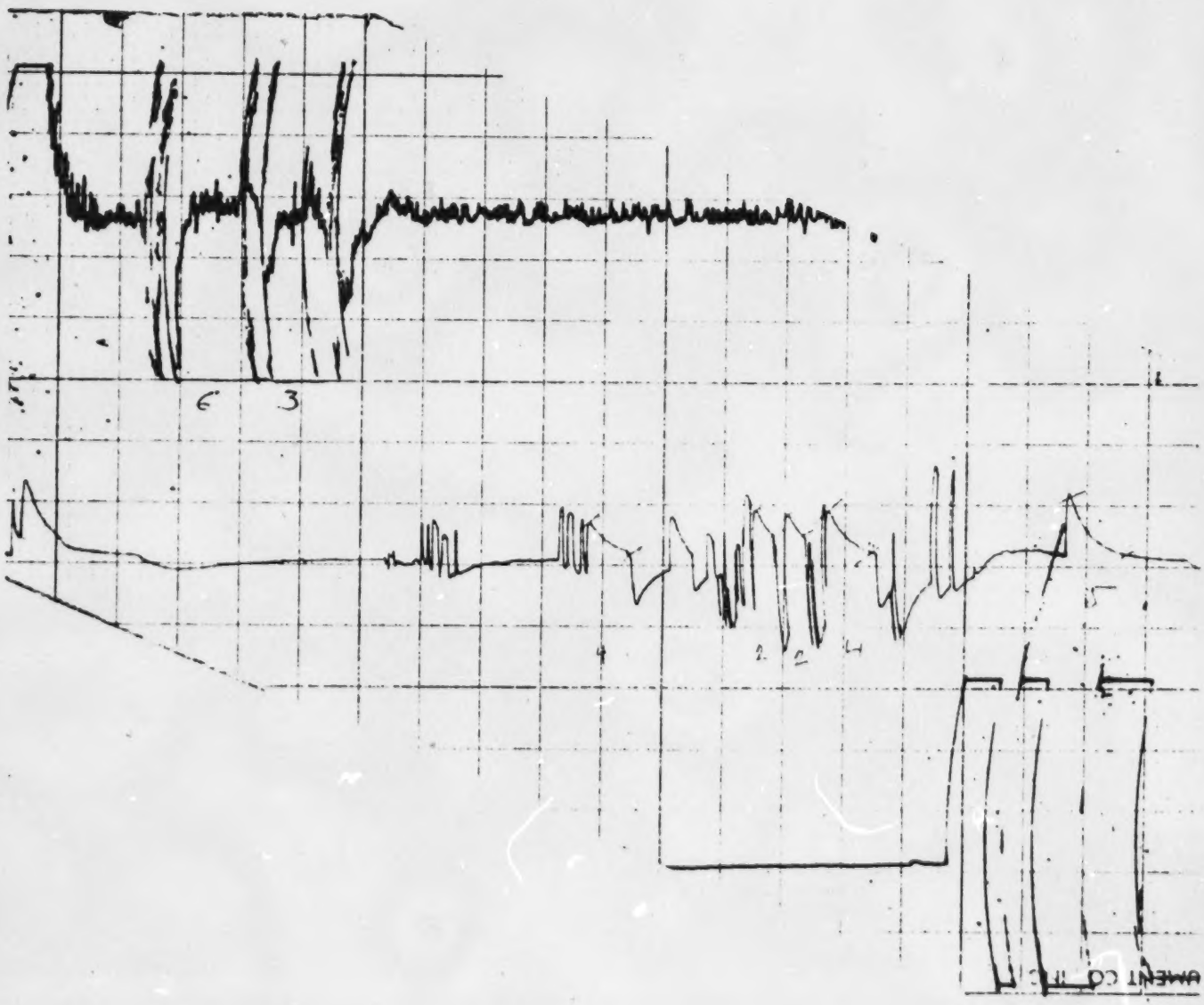
2. Processing and short-term memory time basis vary highly from person to person. Therefore, for different people (after pre-testing), different speeds of recording are used.

Pictures of low speed and high speed EEC and EKG



3. Comparative reading must take in account the changes in tracking.

Picture of mask for heterogenous tracking



Specific tests:

A number of specific tests could be performed either on the materials for the selection in media peice (film, TV program, display), or on the finished artwork. Each test could help the artist in a different decision, or phase of production:

1. General Readability (or Input) Test:

This is the test, where we run the series of materials (pictures, recordings, film shots, TV sequences) for the selected sample of the audience. It is the easiest test, and also the fastest one - the time of the test is the same as the time of the artwork performed.

Several points should be observed:

a. During the pre-test, the stimuli or signs should be relevant to the borders of the sensoric fields or ranges.

b. The test should immediately (till 2 minutes time) follow the pre-test.

c. When the initial input channel is steadily diminishing the activity, signifying the rising fatigue of the test person, the test should be stopped and re-run.

In the diagnosis, not the isolate input curve, but the envelope curve is significant. It shows the general input, general processing and parts (times) of media pieces called "domains".

2. Decision (Selection) Test:

This is the test, where we search for information "domain" (part of a picture, specific shot in a film, sequence in TV program). For this, after the general readability test, the "domain" test could follow. It consists of a performance of an isolated information piece with a short pre-test and a post-test period. The result should be related to the first test. If comparable, the strength of the information domain lays in piece itself. If there is a relative difference, the information impact has a cumulative character.

3. Basic Media Tests (colour, movement shape):

Those three sub-tests are performed, if we are searching for the specific information impact of a certain colour, a certain shape in picture, or a certain direction or speed of movement in the picture. If all three tests are working with real or stimulated input, the measurable impacts are related back to the test No. 1, or to the pre-test, with similar stimuli.

4. General processing test:

This test is geared toward the information processing of certain stimuli. It should be combined at least from two channels: one, containing particular sensoric input tracking (audio, visual); the second, from EEC recording on particual parts of the neocortex. Diagnosis could be done either on binar decision mapping, or on a particular part of the information (picture, sound). If a part recognition is in search, a plotter should be added to the sensory track.

5. Stress Wave test:

This test is done if we are searching for stress wave development during the processing of information. It should consist of sensory input tracking (ev. plotting), EEC channel and in time - synchronize the EKG channel. The electrodes should be on the main veins of small circulation circuit, with ground on chest part. When recorded - the part of the information input, the stress wave is immediately visible on EKG strip, within the 1-2 sec. range from the input. The intensity will vary highly from person to person. The length of the impact could cease within a few seconds, or could be prolonged, in diminishing curves, for a longer time, even without any further input (bouncing stress waves).

6. Reaction tests:

These tests are performed, if we wish to know the person's reaction, or desire to feed-back on the information input. It consists of a sensory track,

EEC and EKG plugged as control channels, and EMG and GSR as main recording channels. EMG channel has significance for immediate responses, the GSR for cumulative responses.

Methodology of testing

a. Preparation of test subject selection -

Following are rules for test subject selection:

1. Test subject should agree voluntarily to undertake the test measurements, and sign the release,

2. By oral questions, brief medical check-up is made. The pathological and retarded cases should be excluded from test audience sample. Histology of each case is recorded in confidential manner

3. The aim of research. method of research and instrumentation of test is explained thoroughly to each person so that possible fear and stage fright against laboratory environment is avoided. If in this stage difficulty occurs, such a subject should be excluded from testing.

b. Test performance -

These are necessary parts of each test made:

1. Input pre-test: For each input channel, following pre-test should be made: range intensity, range contrast, range field. The ranges of visual or audio perception should be aligned with the ranges of the input instrument record. The zero stage should be aligned with no-input state.

2. Processing pre-test: For EEC and EKG channel, range of recording should be aligned with basic binar response of subject (open-close for visual, sound-no-sound for audio). For GSR and EMG channel the verbal direction to desired or non-desired state should be aligned with range of recording.

For both pre-tests, several repetitions within a close time range (approx. 30 seconds) are necessary. The reading should be identical on at least three following recordings.

3. First test run: Within short span of time, of both pre-tests (approx. 2 min.), the first run of test collection should be made. Time spans between the stimuli display should not overlap incidental information processing.

4. Oral check-up: Right after the first test run, a short oral check-up should be made, with reference to the registered reactions. Most of the questions should be geared to the parts of the test run, where either non-aligned recordings occured, or where a significant reaction was obtained. The reason for oral check-up is to eliminate possible side-effects (motoric reactions, metabolic reactions, etc.) not related to the displayed stimuli.

5. Second test run: Approximately after 10 minutes from previous stage, a second test run should be made, preceeded by both pre-tests, once more made. On the second test run, the instrumentation should be aligned as close as possible to the parameters of the test run No. 1. All differences should be marked on pre-test (adjustment of potentiometers, follow-up of samples). Special attention on the second test run should be devoted to the areas of high reactions (information domains), and in this case a high speed of recording should be adjusted.

6. Marking stage: After the test is completed, the researcher should go over with the test subjects, showing him/her the test results, asking questions in order to verify the test results. Test should be cleared of the accidental results (instrumentation or operational mistakes), and the areas of high intensity results should be marked by envelope curves. Slide rules should be used for alignment of time log for channel interactions.

c. Test diagnosis -

Following are the baisc rules for biometric tests diagnosis:

In input area -

a. general activity characteristics:

When looking on eye-trac or audiospectrographic (phonographic) recording, the overall activity pattern should be easily visible. In both cases, the number of fixations give us an indication of quantitative level of information input.

b. Information domain characteristic:

Whenever a dense, short fixations period is occurring, cummulating within a few seconds range many fixations, and this period is followed by long, but sharply distinguished fixations, there is high probability of information domain interception. Such an occurance could be easily checked up in X-Y plotting of image or reading of notation (in musical score).

c. Input storage periods:

There are visible marks on each input recording, when activity of sensor is temporarily decreased for short amount of time, periodically. In visual tracking, this could correspond with muscular activity of the eye (blinking for example), but is not necessarily dependant on physical activities of the eye. The sign has a typical V characteristics of various amplitude. The slip should always have more than 30° angle and should not be delayed for more than 2/10 of second. It is on the lower border of persistence

of vision (1/6 of second). In audio tracking, the slip could last even longer. Input storage periods are signifying the renewal of optical visual reading periods, from where the sensor is departing on new and different pattern of interception.

d. Basic media characteristics -

Intensity, contrast, colour and movement are basic media, intercepted by eye. Each of these leave a distinctive pattern on biometric record. Intensity is related to the amplitude of recording. Contrast to the length of fixations. Colours are producing the various lengths of fixations (shorter wavelengths, shorter: orange, red; longer wavelengths, longer: blue; the longest fixations are produced by the wavelength around 500-560 mmc and in yellow-green area).

Movement produces the distinctive marks of slips on recording. The more fluent the slip, the faster the movement inside the image or image itself.

In processing and storage area:

In this case, we are working with system (brain neocortex), which is in relative state of constant activity. We must distinguish the bio-perceptual rhythmical patterns from processing, storage and search patterns; the metabolical patterns from specific neural circuitry patterns, and specific excitations on part of neocortex from stress wave excitations.

a. general activity characteristics:

When looking on multi-channel recording, the overall activity pattern is visible in variations of amplitudes, differing sharply from rhythmical bioperceptual patterns, which could be aligned with short time distance (to 1.5 sec.) from input of perceptual stimuli. The activity points could have a various amplitude and various time of durations, could be overlapped or could cease after activity pattern, not depending on the duration of initial stimuli.

b. Storage pattern:

Storage pattern could be spotted on multi-channel recording (mostly on EEC channel), with characteristic triangle recording. After initial excitation the amplitude is diminishing gradually, ending on different recording from biological rhythm, and similar to the initial excitation record. When high speed is used, it could be even spotted the slowly change from stored to the biological rhythm information processing. (Bio-chemical chain).

c. search pattern:

When several high excitation peaks are occurring within the range of 0.5-1.6 second, it is a high probability that an intensive search is happening within a close range in neocortex. The search could or could not result in the storage pattern. In most of these cases, the bio-rhythm after the search is showing on distinctive differnece, if any storage had resulted from search or not.

d. stress wave pattern:

There are basically two kinds of stress wave indications: on EEC channel, it is a gradually increasing amplitude within a range of one second, creating the vivid triangle shape of signal. The end of triangle is usually ending in longer activity on high amplitude. The second indication is usually visible on EKG channel: it is a high variation of envelope curve (excluding the spikes of biorhythm at EKG). These two variants (EEC and EKG) have specific co-incidence: if EKG is preceeding in stress wave EEC, subjects are inclining to cause the rational thinking as a beginning of stress wave state.

In both areas (input and processing) the decay of activity or decrease of neural functions (fatigue) could be similar. The differences could be discovered either by:

a. increasing the amplification of signal: in this case, biological rhythm will produce vivid large periodic pattern;

b. increasing of the speed of recording: in this case, shapes of signal will be repeated with great similarities.

VI. Test approaches for complete diagnosis:

1. Pre-test

This test belongs to the general preparation of all following tests, should be done immediately before test runs. Is aimed to the delimitation of sensoric field, delimitation of reaction time, processing abilities of subject, search abilities, storage occurrencies. In the diagnosis, not the isolate curve or fixation, but the cover curve is significant.

2. General readability test

This test is aimed to the general information input, processing and storage. Envelope curves are most important indicators, as well as high amplitudes areas and dense excitation peaks areas.

3. Decision/selection test

This test consists of high speed sectional test run of the stimuli part, where in general readability test either high excitation or dense high amplitude excitation had happened. The diagnosis of the test should reveal the structure and characteristic of information domain. It could also reveal the direct or cummulative impact within information cascade.

4. Basic media tests (colour, movement, shape)

Each of these tests consists of comparative reading of input channel plotted towards a specific characteristics of stimuli (picture). The occurrencies within the basic media become visible, when specific plotted information part is changed, or parameters of input are changed. The registration received is compared with general readability test.

5. General processing test

In this test multi-channel biometric tracking is used, with EEC channel in basic operation, and sensoric tracking (ev. EKG), as supplementary time log tracks. EEC channel then leads to diagnosis. If only binary decision are sought, event recorder is plugged on EEC channel.

6. Stress wave test

In this test we search for stress wave development during the processing of information. It consists of sensory input tracking, (ev. plotting), EEC channel and in time-synch the EKG channel, with electrodes following the small circulation circuit, ground on chest. The stress wave becomes immediately visible on EKG channel, within the 1-2 second range from input. The intensity of recording will highly vary from person to person. The length of impact could cease within few seconds, or could have characteristics rhythmical prolonged duration (bouncing wave).

7. Reaction test

There are three kinds of reaction tests: general (positive-negative, with zero in the centre of registration), negative (resistance test), and positive (action test). General reaction test consists of GSR channel as leading one, with sensory tracking and EEC as complementary channel. Negative (resistance) test is done with combination of GSR and EEC channel. Positive (action) test is done with GSR as leading channel and multiplexing of EEC and EKG for precise time log. In all the reaction tests it should be important that the pre-test, showing the person's reaction attitude is leading key to the diagnosis. By different persons, the peaks of GSR recording could belong to different stimuli. In all the cases EEC record should be consulted, before final diagnostic decision is made.

These tests can be indicators either for the communication biometric research into impact of information source, transmission condition or receiver characteristics. But, for each part of the information chain, the emphasis on input must have a different form. For example, if we are searching mainly for an information source (film, TV program, display), the sample of audience should selected comparative to the factual situation, with medical check-up and conditioning for laboratory tests. If transmission conditions (exhibition hall, auditorium, TV set) is tested, the controlled design of the environment will prevail. If the receiver attitudes are tested, the size of sample, the stratification and demographic or should be emphasized.

Most of the tests in communication biometric research methodology are designed for direct help before and during the production of the media piece. They serve the artists as helping tools to relate his own impression, feelings, or estimates in environment, where the artist could not have direct experience (as in most cases of television production). The tests could also be used, up till a certain level, for the job counselling and training purposes, to reveal the media skills, talents or abilities of cameramen, actors, directors, writers, and producers. The <u>least productive use</u> of the tests is post-production evaluation, namely for administrative (contracts) purposes. This role could easily undertake the verbal, graphical, or recorded tests, well known from basic experimental psychology.

The main asset of the biometric tests enables the artist to associate himself with the living sample of his future audience, and the way how these people will perceive the finished artwork (film, television program, exhibition), especially in pre-production periods where very little is visible or finished from the full media piece.

Testing of location for future show, testing of designs, sets, costumes, graphics, acotrs' études are very valuable check-ups for any artist in the media team.

Another asset of the tests enables management of media network to do a fast, repeated analysis of the audience, faster and perceptual spectra about its pattern and changes, before a main decision about new television programs, and film exhibitions are made.

The main asset of the tests also enables program researchers to select materials (pictures, data, words) with certain impact from numerous sources, and could result in enormous time and cost savings.

III. History and Future of Biometric Research

Although connections between neural and psychical processes are mentioned faintly by Paracelsus, the first scientific experiments in this area began in the 19ty century.

The Austrian physiologist, Johann Evangelist Purkinje (after whom Purkinje cells in the human brain are named), had made a series of experiments during the period between 1834 - 1852 in Vienna and Breslau, aimed at a connection between the human brain and psychical processes of human behaviour. He constructed a series of stroboscopes, named "kinesiscopes" for primitive tachistoscopical observation of images and the response to the series of test pictures (made on daquerrotypes) matched with data regarding blood pressure (blushing), body temperature and speed of mnemomotoric movements of the face and body. Results of this research were presented to the Austrian Academy of Science in 1852 with a major classification of human behavioural types (choleric, sanquinic, melancholic...). This classification was used until the end of the 19th century in psychiatry.

H. Helmholz observed in the years 1853-1861 the response of the human eye to the psychical events (fear, surprise, joy) in great detail, and tried to connect the saccadic movements of the eye to the person's spychical nature. He devised a primitive ophtalmoscop, working on the principle of the corneal reflection on a gas flame, registering the deviations on an horizontally moving photographic plate.

Jean Ettienne Marey, the French physiologist, performed numerous experiments during the years 1874-1886 with cardiographic registrations in his physiologic laboratory. He observed a definite coincidence between psychical processes and the cnahge of heart beat rates, working with mechanical and pneumatical cardiographic instruments.

Adalbert Londe constructed in 1888 a special chronophotographic camera

for the registration of multiple physiological responses.

The first electrophysiologic experiments were attempted in various countries during the first two decades of the 20th century. The first distinct EEG registration known is from G. Leurier's Laboratory in Paris in 1913. At that time, the electrical response from the brain's cortex was believed (incorrectly)to be a direct measure of the "rate of thinking" or "intelligence". Neither instrumentation, nor the electrodes were capable of registering more than a slight deviation of the ohmeter needle. The first registration of EEG responses on paper appeared in 1924, the first EMG registered response in 1928 and GSR (or lie detector registration) in 1931.

There were various theories of what caused the fluctuation of electromagnetic field within the human body, ranging from the theory of "fields", "neuroelectrical mechanism" to sheer postulates of "energy emanators" and "ESP electrical power potentials".

In 1939, the Czech neurophysiologist, J. Laufberger, postulated the first scientifically documented theory of "neuron circuitry". Under his theory, the electrical potential and its changes are relevant to the level of inner energy of the neuron cell and the fluctuation of such energetic potential is exponent of the"work" the neuron does. He also postulates the interconnection of neurons via axons into the "circuitry", and associated the spike of EEG recording with passing energy quantum through the meassured point. This theory was revolutionary when very little was known about the mechanical changes inside the neuron cells, as well as regarding the functions of the cell membranes.

In 1946, Norbert Wiener advanced the system theory under the new name of "cybernetics" and part of his work had an influence on the thinking of the human brain as an information processing system. As an indirect result of this thinking, the Swedish neurophysiologist, S. Malcolm, developed the first information scheme of the brain in 1951 and postulated the interconnections between the symptomatic and peripheral neural systems. His work gave solid ground for further study of EKG, GSR and EMG responses to the psychical processes.

Between the years 1952-1958, the Belgian researcher, Ing. Sallesi-Lavergne, built the first known biometric laboratory for the measurement of physiological responses to films in Bruxelles. He employed a combination of psychological and physiological measurements. The indirect observation and conditioning (via infrared photography) was combined with GSR and ESR response registration.

During the same time, two other biometric laboratories were built in Czechoslovakia and Russia. At Purkinje Physiological institute in Prague there was in operation a five-channel biometric laboratory aimed at the measurement of responses from the psychical impact of exhibitions, museums, galleries and various propagandistic materials. The results of this endeavour later led to the development of unconventional exhibition styles and performances, known as polyecran, Laterna Magica or kinoatomat.

In the Soviet Union, Prof. Yarbus started experimentation with physiological measurements of audiences in 1952, and perfected the electroretinographic instrumentation and methodology to a great extent. The major part of the work was carried out in Moscow during the '50's and '60's, but the laboratory ceased its activity after 1967.

In Japan, Prof. Yagi started his experimentation with multichannel biometry in the early '60's and developed a very sophisticated biometric laboratory at Nihon University in Tokyo. The Japanese contributed greatly to the miniaturization of biometric scanning equipment and to the indirect increase of electrode sensitivity (amplifiers).

A major breakthrough was presented in 1965 with the invention of the distant electrode scanner (Harrison, England) and a very sensitive barium lythium electrodes, although practical use was hampered by a high level of noise present within the scanned signal.

In the USA, the long tradition of electrophysiological responses research dating from 1921 (McCall, Greene, Laskin) was first enhanced during the '30's when experiments of a biometric nature were taking place in Bloomington, Indiana (Gilbert, Morse, Dunn), in Baltimore (Bailey, Miller),and in Rochester (Minn). The second major advance occured here during the '50's (Haber, Stark, Atkinson, Hubel, Campbell, Thiel) with specialized recording of various biometric channels. During the '60's, the first spectral analysis of EEG were performed by Zeitlin, Gevins and J.P. Spire, and similar work was carried out in the analysis of auditory and visual stimuli by Stacy, Lear, Griffin and Olivier.

In the past ten years, we can see a number of approaches or experiments done in the USA and Canada with close pertinence to the biometric research of films, radio and television programs. The most publicly known biometric channel used is of visual information input, or the so-called "eye movement studies". Here, the number of experiments are numerous, with at least four major groups of experimontors, several manufacturers of in strumentation and an unknown number of applications.

1. The baisc tachistoscopic research is carried out at Bloomington, Indiana, with the adjoined largest US manufacturer of instrumentation (Lafayette).
2. MIT with its Advanced Visual Studies group carries out experimentation with a combination of electro-oculography and electroretinography with adjoint manufacturer of instrumentation (Biometric/Narco Medical group).
3. A los Angeles Group is working at UCLA under Prof. H. Suber on the cognitive aspects of visual stimuli - with the support of a US dealer of Japanese instrumentation (National Camera Corp.)
4. In Montreal, Canada, Technolab Industries have researched intensively into the aspect of visual sensory tracking.

Much less is known of researchers in the EMG and GSR responses:

1. Kinsman, Robinson and Gatchel researched GSR and EKG responses to the speech.
2. J.E. Fletcher at the University of Georgia was very active in the field of GSR measurements, applied to the cortical information processing.
3. R. Wells applied GSR and BSR measurements to the reactions of a cognitive nature.
4. J.R. Kennedy experimented in Toronto with GSR measurements applied to films.

The least clear is the situation in the application of EEG measurement, as here the signal carries enormous quanta of noise.

1. Walter and Peterson (at J. Hopkins Hospital, Baltimore) performed the first attempts of EEG spectral analysis, using a short piece of film as the stimuli in 1969.
2. Blackman, Cooley, Lewis and Welch performed first Fournier transforms of EEG recordings, using as stimuli a series of photographs and recorded pieces of music in 1975.

3. Remond, Smith, Andrews and Sampson attempted the first chemo-spectrographic analysis with the use of sonic detectors, using the TV commercial as stimuli in 1977.
4. At Stanford Research Institute's neurophysiologic laboratory, experiments are underway with the use of acoustic optical chemospectrographical scanning (holographic system), where regular TV programmes are used as stimuli.
5. In Montreal at Concordia University, a multi-channel biometric laboratory tests the information impact of films and television programmes since 1974.

If we look at current and future uses of biometry in film and television, the following streams can be foreseen:

1. Within a few years, more laboratories such as ASI in Los Angeles, will establish themselves, using biometric instrumentation.
2. Within an academic field, we may encounter a dozen or more universities active in biometry (Indiana, UCLA, Columbia, Stanford, MIT) leading in research instrumentation and laboratory set-up.
3. In clinical biometry, we can foresee the establishment of several biocybernetic laboratories within major hospitals (two are already in operation at J. Hopkins, Baltimore and Pallisades, New York; another two are in construction - the Mayo Clinic in Rochester and one in Ann Arbor, Mich.)
4. In instrumentation, we can see a certain decline in development within USA territory, and a rise in Japan and Europe (Germany, Sweden).
5. A major thrust in methodology goes from the single channel recording to multi-channel recording, then to spectrographic and Fourier transform analysis, to the computer diagnosis.

During the next decade, the emphasis will be definitely on the multiplex EEG recordings, with sonic and optical/sonic sensing of the brain, and with distant electrodes in the not so distant future. In the meantime, various telemetric set-ups (such as Datel) will be improving the range and efficiency of signal transfers.

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